Benefit-Cost Analysis Supplementary Documentation

BUILD Grant Program

Jefferson Avenue and 20th Street Revitalization Corridors

St. Louis, Missouri

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Table of Contents

List of Tables

Benefit-Cost Analysis Supplementary Documentation

1. Executive Summary

The City of St. Louis and its partners are committed to providing focused investment in the long-distressed area north of Downtown St. Louis. This commitment was strengthened by the announcement of a new $1.75 billion federal investment to relocate the National-Geospatial Intelligence Agency (NGA) from its existing location south of Downtown to this north St. Louis neighborhood. This significant investment will provide a state of the art facility for the NGA and its employees, and will provide the catalyst this community needs to revitalize after decades of decline. However, the area north of Downtown St. Louis will not reach its full potential without a significant infrastructure investment to connect the NGA employees and related businesses to the community it will call home.

The Jefferson Avenue and 20th Street Revitalization Corridors project is one of several sub-projects identified to be completed to support NGA's relocation and other future development opportunities throughout north St. Louis.

The project includes improvements to two city streets that together will effectively serve all users in the area including vehicles, trucks, bicyclists, pedestrians, transit riders and emergency responders. The first of these corridors is 1.88 miles of Jefferson Avenue/Parnell Street (referred to as Jefferson Avenue) from Market Street on the south to Natural Bridge Avenue (MO Route 115) on the north. Jefferson Avenue is a major north/south thoroughfare within the City of St. Louis that has connections to both Interstates 44 (I-44) and 64 (I-64). The existing Jefferson Avenue right-of-way is wide with substandard pedestrian and roadside facilities. The bleak nature of this street's current condition will deter developers and investors away from the area, even with the economic catalyst of the NGA.

The second corridor is 1.64 miles of 20th Street between Market Street and St. Louis Avenue. 20th Street provides a continuous north-south connection from Downtown into the north neighborhoods, including the NGA site. This is a local roadway with significantly lower traffic volumes than Jefferson Avenue; it connects to the Union Station MetroLink light-rail station. It is also adjacent to many existing businesses, residences, schools, and parks. At the south end of the corridor, a Major League Soccer stadium is being constructed at 20th and Market, and the route is two blocks from the new NGA site. Therefore, 20th Street is ideal for relocating the bicycle lanes that are being eliminated on Jefferson Avenue and is an excellent corridor complement.

BUILD funding for the Jefferson Avenue and 20th Streets Revitalization Corridors project will enable the City of St. Louis to convert excessive roadway infrastructure along Jefferson Avenue into more productive uses that provide for safe and convenient travel for pedestrians and cyclists; increase traveler safety; reduce vehicular delays; improve access to businesses to spur private investments along the corridor and in the community; and lay the groundwork for further Smart City investments in the area. A table summarizing the changes expected from the project (and the associated benefits) is provided below.

Table ES-1: Summary of Infrastructure Improvements and Associated Benefits

Current Status or Baseline & Problems to Be Addressed	Type of Impacts	Population Affected by Impacts	Monetized Benefit (Undiscounted, $2018)	Section #
Excessively wide, antiquated, and underutilized roadway in a state of disrepair, lacking sufficient bicycle and pedestrian facilities and generating significant safety concerns	Crash Reduction Benefit – Motor Vehicles	Pedestrians, cyclists, and roadway users	$135.9 Million	7.1
	Crash Reduction Benefit – Bikes and Pedestrians			
	Travel Time Savings for Vehicles	Drivers and automobile passengers	$84.8 Million	7.2
	Pavement Maintenance Savings – Reduced Roadway Area	State and local governments	$977 Thousand	7.3
	Pavement Maintenance Savings – Modal Diversion From Driving		$1.5 Thousand	
	Emissions Reduction - Modal Diversion From Driving	General public	$1.9 Thousand	7.4
	Reduced Mortality Benefit – Cyclists and Pedestrians	New cyclists and Pedestrians	$34.7 Million	7.5
	Trip Quality Benefits – Cyclists and Pedestrians	Existing cyclists and pedestrians	$5.8 Million	

The period of analysis used in the estimation of benefits and costs corresponds to 25 years, including 5 years of construction and 20 years of operation. The total discounted project costs are $28.2 million (in dollars as of 2018), as represented in Table ES-2.

Table ES-2: Summary of Project Costs

	Project Capital Cost
Dollars as of 2020, Undiscounted	$38.99 Million
Dollars as of 2018, Undiscounted	$38.11 Million
Dollars as of 2018, Discounted at 7%	**$28.23 Million**

A summary of the relevant data and calculations used to derive the benefits and costs of the project are shown in the Benefit-Cost Analysis (BCA) model (in dollars of 2018) also included with this application. Based on the analysis presented in the rest of this document, the project is expected to generate $89.6 million in discounted benefits and $28.2 million in discounted capital costs, calculated using a 7 percent real discount rate. Therefore, the project is expected to generate a Net Present Value of $61.4 million and a benefit-cost ratio of 3.17.

In addition to the monetized benefits, the project would generate benefits that are difficult to quantify. A brief description of those benefits is provided below.

Safety

The addition of medians, modern signals, turning movement changes, widened and continuous sidewalks, and improved bike facilities will improve safety in the corridors. For example, a bicycle path will be added along 20th Street between Market Street and St. Louis Avenue. Another will be added along North Market Street, and ADA-compliant improvements will be made to the corridor, working in conjunction with the new bicycle plan.

State of Good Repair

The project will result in reconstructed existing roadways as recommended in the pavement condition report. This includes mill and overlay of existing pavement. It will also widen and create continuous, ADA-compliant sidewalks and buffers for protection on both sides of Jefferson Avenue. A net reduction in pavement area and lane miles will also result in operations and maintenance cost savings.

Economic Competitiveness

The project will support the relocation of the National-Geospatial Intelligence Agency (NGA), a $1.75B campus in north St. Louis. This investment will provide a state of the art facility for the NGA and its employees, and the proposed improvements will further enhance the community.

Together with the NGA relocation, the project will decrease transportation costs, improve access, and reduce the burden of commuting; improve long-term efficiency and reliability in the movement of workers; increase the economic productivity of land, capital, and labor; induce long-term job creation and other economic opportunities, and contributes to the growth of the economy.

Environmental Sustainability

Trees are being added as part of this project, increasing the tree canopy. Stormwater best management practices are being utilized to improve water quality and reduce the strain on the stormwater infrastructure.

Quality of Life

Longitudinal green median will be added in portions of the project. Improved active transportation infrastructure will provide alternative, healthier transportation modes for area workers and residents. Additionally, the improved sidewalks, LED street lighting, decorative pedestrian-scale lighting, stamped concrete, ornamental grasses and street trees will further enhance the quality of life in the community.

Innovation

A Smart City better manages public assets and infrastructure decisions using data. The City of St. Louis is committed to its Smart City initiative, and improvements that advance our work in this realm. A full description of the innovative elements of this project is provided in the application. No benefits associated with innovation were monetized as part of the benefit-cost analysis.

Partnership

The Jefferson Avenue and 20th Street Revitalization Corridors project partnerships are numerous and long-standing. The City has engaged the community through Project Connect since 2016 to understand the potential benefits and impacts NGA will have on its future neighborhood. It is focused on eight neighborhoods with a goal to identify priority investments that will help keep existing residents and businesses in the area and encourage new growth in the future. The partnerships include 20 City and Regional Agencies, 3 Federal agencies, 8 community groups, local and national developers/investors, residents and businesses.

2. Introduction

This document provides detailed technical information on the economic analyses conducted in support of the grant application for the Jefferson Avenue and 20th Street Revitalization Corridors project.

Section 3, Methodological Framework, introduces the conceptual framework used in the BCA. Section 4, Project Overview, provides an overview of the project, including a brief description of existing conditions and proposed alternatives; a summary of cost estimates and schedule; and a description of the types of effects that the Jefferson Avenue and 20th Street Revitalization Corridors project is expected to generate. Section 5, General Assumptions, discusses the general assumptions used in the estimation of project costs and benefits, while estimates of travel demand and traffic growth can be found in Section 6, Demand Projections. Specific data elements and assumptions pertaining to the long-term outcome selection criteria are presented in Section 7, Benefits Measurement, Data and Assumptions, along with associated benefit estimates. Estimates of the project's Net Present Value (NPV), its benefit-cost ratio (BCR) and other project evaluation metrics are introduced in Section 8, Summary of Findings and BCA Outcomes. Next, Section 9, provides the outcomes of the sensitivity analysis. Additional data tables are provided within the BCA model including annual estimates of benefits and costs to assist the U.S. Department of Transportation (USDOT) in its review of the application.[1]

[1] The Excel-based BCA model is provided separately as part of the application.

3. Methodological Framework

The BCA conducted for this project includes the monetized benefits and costs measured using USDOT guidance, as well as the quantitative and qualitative merits of the project. A BCA provides estimates of the benefits that are expected to accrue from a project over a specified period and compares them to the anticipated costs of the project. Costs include both the resources required to develop the project and the costs of maintaining the new or improved asset over time. Estimated benefits are based on the projected impacts of the project on both users and non-users of the facility, valued in monetary terms.[2]

While BCA is just one of many tools that can be used in making decisions about infrastructure investments, USDOT believes that it provides a useful benchmark from which to evaluate and compare potential transportation investments.[3]

The specific methodology utilized for this application was developed using the BCA guidance developed by USDOT and is consistent with the BUILD program guidelines. In particular, the methodology involves:

- Establishing existing and future conditions under the Build and No-Build scenarios;
- Assessing benefits with respect to each of the merit criteria identified in the Notice of Funding Opportunity (NOFO);
- Measuring benefits in dollar terms, whenever possible, and expressing benefits and costs in a common unit of measurement;
- Using USDOT guidance for the valuation of travel time savings, vehicle operating cost, safety benefits, and reductions in air emissions, while relying on industry best practice for the valuation of other effects;
- Discounting future benefits and costs with the real discount rates recommended by USDOT (7 percent); and
- Conducting sensitivity analyses to assess the impacts of changes in key estimating assumptions.

4. Project Overview

Jefferson Avenue is a north-south arterial in the City of St. Louis and serves approximately 16,000 vehicles per day. The southern portion of Jefferson Avenue is a Principal Arterial that serves the western end of downtown St. Louis. The remainder of Jefferson Avenue in the project area is a minor arterial that provides direct access to the Downtown West, Midtown, Jeff Vanderlou, Carr Square, St. Louis Place and Hyde Park neighborhoods in St. Louis. The corridor is served by Metro Transit buses and is an important transit route for the corridor. This project will:

- Rehabilitate and reconstruct the existing roadway as recommended in the pavement condition report.
- Initiate a road diet as suggested in the completed traffic study and reallocate the 100-foot wide right-of-way along Jefferson Avenue by reducing the number of thru-lanes from six to four; subsequently this will provide a safer pedestrian setback, allowing for landscaped

[2] USDOT, Benefit-Cost Analysis Guidance for Discretionary Grant Programs, January 2020.

[3] Ibid.

medians and tree lawns and introducing reduced lane widths. This will eliminate the "race-track" feel of this corridor.

- Eliminate old broken up curb line and reconstruct with new curb and gutter.
- Replace the deteriorated, disconnected and non-ADA compliant sidewalk along the roadside with a new and continuous ADA pathway with a pedestrian setback from the new curb line.
- Add longitudinal green medians and intersection bump-outs in portions to promote traffic calming, reduce pedestrian crossing lengths, and create further green space and pervious area for improved storm water management.
- Update the storm sewer system and implement storm water best management practices to improve water quality and reduce the strain on storm water infrastructure.
- Control access by limiting it to only right-in / right-out turns at non-signalized intersections and entrances from Cass Avenue to Palm Street.
- Install new signals that are ADA-compliant at nine intersections, including fiber optic interconnect and license plate readers.
- Implement innovative Smart City Technology along the corridor.
- Update existing street parking facilities to the City's latest standards from Market Street to Cass Avenue, where parking currently exists.
- Construct relocated transit bus stop locations and shelters, following the local transit agency's recently updated standards.
- Remove underutilized and high-stress bicycle lanes and relocate to 20th Street.
- Add street and roadside amenities, including the latest LED street and pedestrian lighting, benches, trash receptacles, wayfinding signage, stamped concrete, streetscape plantings and shade trees.
- Specifically include lighting MoDOT's new Natural Bridge Avenue / Parnell Street roundabout at the northern end of Jefferson Avenue's Corridor with the City's latest Smart City-enabled streetlight pole and LED light.

20th Street is a parallel local route that also provides access to downtown and the surrounding neighborhoods. The proposed project will make 20th Street an important bicycle route in the region that supports the Jefferson Avenue corridor. These two corridors will work in concert to provide exceptional service to all modes. Specific improvements on 20th Street will:

- Add a low-stress bicycle facility along 20th Street between Market Street and St. Louis Avenue, connecting planned GRG bicycle pathways on both ends.
- Add a low-stress bicycle facility along North Market Street between 20th and 23rd Streets, connecting to NGA.
- Construct an ADA-compliant corridor to complement the new bicycle plan.
- Provide the latest LED street and roadside lighting standards, landscaped areas, and street trees where appropriate.
- Install new modern and ADA-compliant signals at six intersections, including a fiber optic interconnect that ties 20th Street to the City's Transportation Management Center.
- Update the storm sewer system and implement storm water best management practices to improve water quality and reduce the strain on storm water infrastructure.
- Update existing street parking facilities to the City's latest standards.
- Reconstruct curb lines and sidewalks.
- Mill and overlay existing pavement.

4.1 Base Case and Alternatives

Estimates of baseline “No-Build” conditions were forecasted over the analysis period and then compared to alternative “Build” conditions in the benefit-cost analysis. The Build scenario assumes that the Complete Streets improvements discussed above will be made to improve transportation for all modes.

4.2 Types of Impacts

The BCA measures impacts on users of the corridors, which include drivers, pedestrians, and cyclists, and external impacts on the local and national population.

The primary benefit of the project is improved safety for pedestrians, cyclists, and drivers. In addition, the quality of all transportation modes (roadway, bicycle, and pedestrian facilities) is improved, and residents are better connected to employment centers, health facilities, educational institutions, and other attractors.

The general population will benefit from improved health, relative to the base case, resulting from reduced emissions due to the reduction of vehicle VMT. In addition, new walkers and cyclists generate additional health benefits by using active transportation.

Drivers will benefit from improved trip time and reliability because of the improved operational efficiency on the corridor and the availability of other modes of transportation, which will remove some existing drivers from the roadway.

4.3 Project Cost and Schedule

The total capital cost of the full project is estimated to be $38.1 million, in undiscounted 2018 dollars. The project team has prepared a schedule of planning, construction and implementation; construction would occur over five years, beginning in 2020.

4.4 Effects on Selection Criteria

The main benefit categories associated with the project are mapped into the seven merit criteria set forth by USDOT in the table below.

Table 1: Benefit Categories and Expected Effects on Selection Criteria

BUILD Merit Criteria	Benefit or Impact Categories	Description	Monetized	Quantified	Qualitative
Safety	Accident Reduction Benefit - Vehicles	The number of accidents will be reduced by safety enhancements in the corridor.	Yes	Yes	Yes
	Accident Reduction Benefits – Cyclists and Pedestrians	The number of accidents will be reduced by improved crossings and other safety enhancements.	Yes	Yes	Yes
Economic Competitiveness	Travel Time Savings for Vehicles	Travel time savings from reduced congestion due to improved efficiency on the corridor and some drivers choosing to walk or bike rather than drive.	Yes	Yes	Yes
	Reduced Vehicle Operating Costs	As some residents shift from driving to using the new and improved active transportation facilities, we will see a reduction in the number of automobile drivers, in turn leading to a reduction in costs to operate and maintain the vehicle.	No	No	Yes
	Regional Economic Development	Project infrastructure improvements, combined with the relocation of the NGA facility, will revitalize this economically disadvantaged area north of Downtown St Louis.	Yes	Yes	Yes
Environmental Sustainability	Emissions Reduction – Cyclists and Pedestrians	Reductions in greenhouse gas and air pollutant emissions due to changes in auto use as a result of some people opting to walk or bike rather than drive.	Yes	Yes	Yes
	Stormwater Runoff Improvements	Stormwater quality will be improved.	No	No	Yes
	Green space	Green medians and a landscaped verge will be added in the corridor.	No	No	Yes
State of Good Repair	Reduced Roadway Operations and Maintenance Expense	A net reduction in pavement area and lane miles will decrease annual roadway maintenance expenses.	Yes	Yes	Yes
	Pavement maintenance savings	Improved active transportation infrastructure will induce some automobile drivers to walk or bike on the new and improved facilities, reducing pavement wear and tear on existing roadways.	Yes	Yes	Yes

BUILD Merit Criteria	Benefit or Impact Categories	Description	Monetized	Quantified	Qualitative
Quality of Life	New Cyclist and Pedestrian Health Benefit	People not currently biking or walking will be induced to do so as a result of the project. Increased physical activity provides a health benefit. Health benefits to existing users are not quantified.	Yes	Yes	Yes
	Pedestrian and Cyclist Journey Quality Benefits	Redesigned sidewalks and bicycle infrastructure will provide increased journey quality benefits to people who already travel along those means.	Yes	Yes	Yes
	Economic Development	Adding street trees, green medians, and buffers between the sidewalks and the roadway will increase the attractiveness of the project area and encourage commercial and residential development.	No	No	Yes
Innovation	Discussed in the application narrative.		No	No	Yes
Partnership					

5. General Assumptions

The BCA measures benefits against costs throughout a period of analysis beginning at the start of construction and including 20 years of operations.

The monetized benefits and costs are estimated in 2018 dollars with future dollars discounted in compliance with BUILD requirements using a 7 percent real rate. A sensitivity testing at 3 percent is also provided.

The methodology makes several important assumptions and seeks to avoid overestimation of benefits and underestimation of costs. Specifically:

- Input prices are expressed in 2018 dollars;
- The period of analysis begins in 2018 and ends in 2044. It includes project development and construction years (2020 - 2024) and 20 years of operations;
- A constant 7 percent real discount rate is assumed throughout the period of analysis;
- Opening year demand is assumed to be fully realized in 2025; and
- The results shown in this document correspond to the effects of the full Build alternative, which includes the Complete Streets improvements on both Jefferson Avenue and 20th Street described previously.

6. Demand Projections

This section of the technical documentation presents the pedestrian, cyclist, and vehicle projections utilized in the BCA, as well as the general approach used to estimate this activity.

6.1 Methodology

Certain benefits estimated for this project are related to travel time savings and bicycle and pedestrian projections. These projections were generated by project consultants under the following assumptions:

- Travel time analysis generated for the CMAQ application
- Existing and forecasted traffic volumes generated for SLDC Traffic Study
- Mode split estimates generated by the East-West Gateway Council of Governments for the region
- A ½ percent growth rate was assumed along both Jefferson Avenue and 20th Street Corridors from 2020 to 2042. It is also assumed that NGA and other related Project Connect developments will be complete.
- Bike mode share is expected to increase by 4 percent resulting from this project and pedestrian mode share is expected to increase by 1 percent.
- With the completion of the bike facility along 20th Street, it is assumed that the new bike facility would become the primary bike route that serves NGA and related developments; and a significant bike shift would occur from Jefferson Avenue to 20th Street.

Additional information on travel demand projections is provided in the traffic memo that accompanies this application.

Pedestrian and cycling projections assume the following trip purpose distributions:

Table 2: Assumptions Used in the Estimation of Cyclist and Pedestrian Trip Purpose

Cyclist and Pedestrian Trip Purpose	Percentage of Trips	Source
Cyclist – Commuting	5%	National Highway Traffic Safety Administration, *National Survey of Bicyclist and Pedestrian Attitudes and Behavior*, August 2008. Figure 8.
Cyclist – Recreation/Leisure/Exercise/Health	53%	
Cyclist – Other Destinations	42%	
Pedestrian – Commuting	5%	National Highway Traffic Safety Administration, *National Survey of Bicyclist and Pedestrian Attitudes and Behavior*, August 2008. Figure 30.
Pedestrian – Recreation/Leisure/Exercise/Health	49%	
Pedestrian – Other Destinations	46%	

6.2 Demand Projections

The resulting projections for pedestrian and cycling activity are presented in the tables below.

Table 3: Demand Projections – Bicyclists

No Build Bike Trips	***2018***	***2019***	***2020***	***2021***	***2022***	***2023***	***2024***	***2025***	***2026***	***2027***	***2028***	***2029***	***2030***	***2031***
Total Daily Trips	310.0	310.0	310.0	310.0	310.0	311.6	313.1	314.7	316.2	317.8	319.4	321.0	322.6	324.2
Daily Commuter Trips	15.5	15.5	15.5	15.5	15.5	15.6	15.7	15.7	15.8	15.9	16.0	16.1	16.1	16.2
Daily Other Destination Trips	294.5	294.5	294.5	294.5	294.5	296.0	297.5	298.9	300.4	301.9	303.4	305.0	306.5	308.0
Build Bike Trips	***2018***	***2019***	***2020***	***2021***	***2022***	***2023***	***2024***	***2025***	***2026***	***2027***	***2028***	***2029***	***2030***	***2031***
Total Daily Trips	310.0	310.0	310.0	310.0	310.0	372.0	434.0	496.0	558.0	620.0	682.0	744.0	806.0	868.0
Daily Commuter Trips	15.5	15.5	15.5	15.5	15.5	18.6	21.7	24.8	27.9	31.0	34.1	37.2	40.3	43.4
Daily Other Destination Trips	294.5	294.5	294.5	294.5	294.5	353.4	412.3	471.2	530.1	589.0	647.9	706.8	765.7	824.6
No Build Bike Trips	***2032***	***2033***	***2034***	***2035***	***2036***	***2037***	***2038***	***2039***	***2040***	***2041***	***2042***	***2043***	***2044***	***2045***
Total Daily Trips	325.9	327.5	329.1	330.8	332.4	334.1	335.8	337.4	339.1	340.8	342.5	344.2	346.0	347.7
Daily Commuter Trips	16.3	16.4	16.5	16.5	16.6	16.7	16.8	16.9	17.0	17.0	17.1	17.2	17.3	17.4
Daily Other Destination Trips	309.6	311.1	312.7	314.2	315.8	317.4	319.0	320.6	322.2	323.8	325.4	327.0	328.7	330.3
Build Bike Trips	***2032***	***2033***	***2034***	***2035***	***2036***	***2037***	***2038***	***2039***	***2040***	***2041***	***2042***	***2043***	***2044***	***2045***
Total Daily Trips	930.0	992.0	1,054.0	1,116.0	1,178.0	1,240.0	1,302.0	1,364.0	1,426.0	1,488.0	1,550.0	1,557.8	1,565.5	1,573.4
Daily Commuter Trips	46.5	49.6	52.7	55.8	58.9	62.0	65.1	68.2	71.3	74.4	77.5	77.9	78.3	78.7
Daily Other Destination Trips	883.5	942.4	1,001.3	1,060.2	1,119.1	1,178.0	1,236.9	1,295.8	1,354.7	1,413.6	1,472.5	1,479.9	1,487.3	1,494.7

Table 4: Demand Projections – Pedestrians

No Build Pedestrian Trips	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**
Total Daily Pedestrian Trips	1,230.0	1,230.0	1,230.0	1,230.0	1,230.0	1,236.2	1,242.3	1,248.5	1,254.8	1,261.1	1,267.4	1,273.7	1,280.1	1,286.5
Daily Commuter Trips	61.5	61.5	61.5	61.5	61.5	61.8	62.1	62.4	62.7	63.1	63.4	63.7	64.0	64.3
Daily Other Destination Trips	1,168.5	1,168.5	1,168.5	1,168.5	1,168.5	1,174.3	1,180.2	1,186.1	1,192.0	1,198.0	1,204.0	1,210.0	1,216.1	1,222.1
Build Pedestrian Trips	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**
Total Daily Pedestrian Trips	1,230.0	1,230.0	1,230.0	1,230.0	1,230.0	1,246.0	1,262.0	1,278.0	1,294.0	1,310.0	1,326.0	1,342.0	1,358.0	1,374.0
Daily Commuter Trips	61.5	61.5	61.5	61.5	61.5	62.3	63.1	63.9	64.7	65.5	66.3	67.1	67.9	68.7
Daily Other Destination Trips	1,168.5	1,168.5	1,168.5	1,168.5	1,168.5	1,183.7	1,198.9	1,214.1	1,229.3	1,244.5	1,259.7	1,274.9	1,290.1	1,305.3
No Build Pedestrian Trips	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**	**2041**	**2042**	**2043**	**2044**	**2045**
Total Daily Pedestrian Trips	1,292.9	1,299.4	1,305.9	1,312.4	1,319.0	1,325.5	1,332.2	1,338.8	1,345.5	1,352.3	1,359.0	1,365.8	1,372.6	1,379.5
Daily Commuter Trips	64.6	65.0	65.3	65.6	65.9	66.3	66.6	66.9	67.3	67.6	68.0	68.3	68.6	69.0
Daily Other Destination Trips	1,228.3	1,234.4	1,240.6	1,246.8	1,253.0	1,259.3	1,265.6	1,271.9	1,278.3	1,284.6	1,291.1	1,297.5	1,304.0	1,310.5
Build Pedestrian Trips	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**	**2041**	**2042**	**2043**	**2044**	**2045**
Total Daily Pedestrian Trips	1,390.0	1,406.0	1,422.0	1,438.0	1,454.0	1,470.0	1,486.0	1,502.0	1,518.0	1,534.0	1,550.0	1,557.8	1,565.5	1,573.4
Daily Commuter Trips	69.5	70.3	71.1	71.9	72.7	73.5	74.3	75.1	75.9	76.7	77.5	77.9	78.3	78.7
Daily Other Destination Trips	1,320.5	1,335.7	1,350.9	1,366.1	1,381.3	1,396.5	1,411.7	1,426.9	1,442.1	1,457.3	1,472.5	1,479.9	1,487.3	1,494.7

7. Benefits Measurement, Data and Assumptions

This section describes the measurement approach used for each benefit or impact category identified in Table 1 (Benefit Categories and Expected Effects on Selection Criteria) and provides an overview of the associated methodology, assumptions, and estimates.

7.1 Safety

Countermeasures implemented as part of the project are expected to reduce traffic crashes along the Jefferson Avenue and 20th Street corridors, yielding monetized safety benefits. Safety improvements along the 20th Street corridor include pavement resurfacing, installing separated bike lanes, installing speed humps where separate bike lanes are not provided, ADA upgrades, signal upgrades, and more clearly defined signalized intersections. Safety improvements along the Jefferson Avenue corridor include eliminating a travel lane, pavement resurfacing, adding primary signal heads, and installing Flashing Yellow Arrows (FYA) at signalized intersections.

7.1.1 METHODOLOGY

In order to generate forecasts of No-Build project area crashes in 2022, project consultants aggregated 10 years of historical crash data (2010 to 2019) for the area and extrapolated crash frequencies forward by a 5% escalation factor, representing background traffic growth.

The following Crash Modification Factors (CMFs) were then applied the 2022 No-Build crash projections to estimate crashes in the 2022 Build scenario for the 20th Street corridor:

- "Resurface Pavement" (CMF ID = 9289)
  - CMF = 0.929 for all crash types and severities
  - Applies to: all locations along corridor
- "Install Separated Bicycle Lanes (Separated by parking lane plus)" (CMF ID = 8257)
  - CMF = 0.714 for all crash types and severities
  - Applies to: Market, Chestnut, Pine, Olive, Locust, St. Charles, Washington, Lucas, Linden, Delmar, Dr. MLK, Cole and Carr.
- "Install Speed Humps" (CMF ID=132)
  - CMF = 0.60 for all crash types and injury crashes
  - Applies to: Biddle, O'Fallon, Phipps, Cass, Mullanphy, Howard, Madison, Maiden, and North Market.
- "Install Separated Bicycle Lanes (Separated by Concrete Curb only)" (CMF ID = 8259)
  - CMF = 0.687 for all crash types and severities
  - Applies to: Benton Street, Warren Street, Montgomery St and St. Louis Avenue.

The following CMFs were applied along the Jefferson Avenue corridor:

- "Road Diet (Convert 4-lane undivided road to 2-lanes plus turning lane) – 9 or more intersections" (CMF ID = 4727)
  - CMF = 0.93 for all crash types and severities
  - Applies: to all locations along corridor
- "Resurface Pavement" (CMF ID = 9289)
  - CMF = 0.929 for all crash types and severities
  - Applies to: all locations along corridor
- "Changing Left-Turn Phasing from at Least One Permissive Approach to Flashing Yellow Arrow (FYA)" (CMF ID = 4174)
  - CMF = 0.753 for all crash types and severities
  - Applies to: Jefferson with Cass, Pine, and St. Louis Avenue
- "Changing Left-Turn Phasing from Protected-Permissive to Flashing Yellow Arrow (FYA)" (CMF ID = 4176)
  - CMF = 0.922 for all crash types and severities
  - Applies to: Jefferson with Delmar, Dr. Martin Luther Kind, Washington, Locust, Olive, Market, Natural Bridge
- "Changing from Permissive to Flashing Yellow Arrow Permissive Only" (CMF ID = 7698)
  - CMF = 0.892 for all crash types and severities (3 Legged intersection)

    - Applies to: Jefferson at Stoddard
- "Add Signal (Additional Primary Head)" (CMF ID = 1414)
    - CMF = 0.72 for all crash types and severities
    - Applies to: all signalized intersections
- "Install Right-In-Right-Out (RIRO) Operations at Stop Controlled Intersections" (CMF ID = 9821)
    - CMF = 0.55 for all crash types and severities
    - Applies to: Jefferson at Cole St., Mills St, Dayton St., Gamble St., Daytona St., James Cool Papa Bell Ave., Thomas St., Mullanphy St, Howard St., Madison St., Maiden St.
    - Applies to: Parnell St at N. Market St., Benton St., Warren St., Montgomery Ave., University St., Dodier St., Sullivan Avenue, and Herbert St.
- "Conversion of Signalized Intersection into Multi-Lane Roundabout" (CMF ID = 4191 & CMF ID = 4195)
    - CMF = 0.29 for all crash types and Injury crashes
    - CMF = 0.81 for all crash types and PDO crashes
    - Applies to: Jefferson at Natural Bridge Avenue.

In order to estimate crashes along each corridor for the 2041 No-Build condition, the 2022 No-Build rates were increased by approximately 10% to account for general background growth in the study area, representing a 0.5% increase per year from 2022 to 2041. The CMFs of the proposed countermeasures were again applied to the respective corridor 2041 No-Build crash rates to estimate the 2041 Build crashes.

These crash projections are described in more depth in the safety technical memo attached with the application.

The difference between projected crashes in the Build and No-Build scenarios represents the safety impact of project improvements. These averted crashes were then monetized according to USDOT BCA Guidance.

7.1.2 ASSUMPTIONS

The assumptions used in the estimation of safety benefits are summarized in the tables below. This information is consistent with USDOT BCA Guidance.

Table 5: Assumptions Used in the Estimation of Safety Benefits

Variable Name	Unit	Value	Source
Value of Averted Fatality (K)	$ per event	$9,600,000	USDOT, *BCA Guidance for Discretionary Grant Programs*, January 2020.
Value of Averted Incapacitating Injury (A)		$459,100	
Value of Averted Non-Incapacitating Injury (B)		$125,000	
Value of Averted Possible Injury (C)		$63,900	
Value of Averted Property Damage	$ per vehicle	$4,300	
Fatalities per Fatality Crash		1.09	
Injuries per Injury Crash		1.44	

7.1.1 BENEFIT ESTIMATES

Historically, the project corridors have experienced a significant number of crashes, including multiple fatalities. Consequently, crash reduction benefits generated by improved intersections, signaling, and other elements of roadway design are significant, estimated at $47.5 million over the 20-year period, when discounted at seven percent.

Table 6: Estimates of Safety Benefits, 2018 Dollars

	Over the Project Lifecycle		
	In Constant Dollars	Discounted at 7 Percent	Discounted at 3 Percent
Crash Reduction Benefit	$135,925,783	$47,491,042	$84,298,256

7.2 Economic Competitiveness

The proposed Project would contribute to enhancing economic competitiveness by generating travel time savings for all travelers in the project area.

7.2.1 METHODOLOGY

Reduced automobile VHT are calculated using the methodology from the travel time analysis conducted for the CMAQ application with respect to increased average motor vehicle speeds and resulting decreased travel times. The difference in VHT between the Build and No-Build scenarios is monetized according to USDOT Guidance with respect to average motor vehicle occupancy and the value of travel time.

7.2.2 ASSUMPTIONS

The assumptions used in the estimation of economic competitiveness benefits are summarized in the tables below.

Table 7: Assumptions Used in the Estimation of Travel Time Savings Benefits

Variable Name	Unit	Value	Source
Average Passenger Vehicle Occupancy: All Travel	people per vehicle	1.67	USDOT, *BCA Guidance for Discretionary Grant Programs*, January 2020.
Value of Travel Time: Truck Drivers	$ per hour	$29.50	
Value of Travel Time: All Purposes Local Travel		$16.60	
Truck Percentage	percent	11%	Consultant Traffic Analysis
Annual Commuter Days	days per year	250	HDR Assumption

7.2.3 BENEFIT ESTIMATES

Assuming a 7 percent discount rate, travel time savings generate $29.6 million in benefits over the study period.

Table 8: Estimates of Economic Competitiveness Benefits, 2018 Dollars

	Over the Project Lifecycle		
	In Constant Dollars	Discounted at 7 Percent	Discounted at 3 Percent
Travel Time Savings	$84,842,836	$29,634,713	$52,610,468

7.3 State of Good Repair

State of good repair benefits are generated by this project in two forms. First, savings in pavement maintenance expenses are generated as the total area of roadway is reduced in the Build scenario, relative to the No-Build, decreasing the total amount of infrastructure that requires maintenance. The remaining additional pavement maintenance savings are generated on the existing roadway as a portion of automobile drivers shift to bicycle travel. This modal diversion to bicycling, in turn, reduces roadway wear and tear.

7.3.1 METHODOLOGY

Operations and maintenance savings resulting from reduced roadway area are sourced from an engineering estimate of approximately $150 thousand annual roadway maintenance for infrastructure in the No-Build roadway configuration compared to $100 thousand annual roadway maintenance for reduced roadway area in the Build configuration.

To estimate the reduced pavement maintenance costs accruing from modal diversion, new cyclist trip estimates were utilized. These trip figures were multiplied by the number of commuter and destination rider days per year. A pavement maintenance cost per mile was then multiplied by the number of miles per trip. The product of the trips and pavement maintenance cost per trip

generates the total savings associated with reduced wear and tear on roadways. Because not all new riders will be diverting from automobiles, only 10 percent of the total benefit is included in this monetized benefit as a conservative assumption.

7.3.2 ASSUMPTIONS

The assumptions used in the estimation of state of good repair benefits are summarized in the table below.

Table 9: Assumptions Used in the Estimation of State of Good Repair Benefits

Variable Name	Unit	Value	Source
Annual Commuter Days	days per year	250	HDR assumption (5 days per week, 50 weeks per year)
Commuter Annual Factor	trips per day	2	HDR assumption
Annual Destination Travel Days	days per year	208	HDR assumption (4 days per week, 52 weeks per year)
Destination Travel Annual Factor	trips per day	2	HDR assumption
Pavement Maintenance Expense	$ per mile	$0.001	Addendum to the 1997 Federal Highway Cost Allocation Study Final Report, May 2000. Adjusted to $2018 per USDOT BCA Guidance.
Average Trip Length – cycling	miles per trip	1.68	HDR assumption based on length of corridor
Automobile trips reduced per new cyclist		1/10	HDR assumption

7.3.3 BENEFIT ESTIMATES

Pavement maintenance savings accruing from modal diversion are relatively minor for this project. Based on the assumptions and methodology outlined above, just $435 in pavement maintenance savings (discounted at seven percent) are generated when existing automobile users divert to the active transportation modes. However, operations and maintenance savings resulting from a reduction in roadway area are much more significant, yielding approximately $345 thousand in discounted benefits over the 20-year analysis period.

Table 10: Estimates of State-of-Good-Repair Benefits, 2018 Dollars

	Over the Project Lifecycle		
	In Constant Dollars	Discounted at 7 Percent	Discounted at 3 Percent
Operations & Maintenance Savings Reduced Roadway Area	$977,265	$344,937	$608,819
Pavement Maintenance Savings	$1,487	$435	$856

7.4 Environmental Sustainability

Environmental sustainability benefits will be generated by this project as drivers switching to active transportation modes will result in reduced motor vehicle emissions.

7.4.1 METHODOLOGY

Using the methodology described with respect to state of good repair benefits, the anticipated reduction in motor vehicle miles travelled as a result of project improvements was calculated. Emissions rates for vehicles, in grams per mile, were estimated using the EPA MOVES database, and these emissions rates were subsequently used to convert VMT reductions to emissions reductions. Emissions reductions were then monetized according to USDOT BCA Guidance.

7.4.2 ASSUMPTIONS

The assumptions used in the estimation of environmental sustainability benefits are summarized in the table below.

Note that emissions rates sourced from the EPA MOVES database are time series data. The values represented in the table below correspond with emissions rates as of 2020, which are generally representative for summary purposes of the more detailed time series emissions rates employed in the BCA model.

Table 11: Assumptions Used in the Estimation of Environmental Sustainability Benefits

Variable Name	Unit	Value	Source
Value of Reduced Emissions: CO2	$ per metric ton	$1.00 - $2.00	USDOT, *BCA Guidance for Discretionary Grant Programs*, January 2020.
Value of Reduced Emissions: VOCs		$2,313	
Value of Reduced Emissions: NOx		$9,473	
Value of Reduced Emissions: PM2.5		$426,611	
Value of Reduced Emissions: SO2		$55,185	
Emissions Factor: CO2	grams per mile	453.02	EPA MOVES Database; St. Louis County, Missouri; Gasoline-powered Passenger Vehicles on Urban Unrestricted Access roadways; 12.5 mph <= speed <= 17.5 mph.
Emissions Factor: VOCs		0.0262	
Emissions Factor: NOx		0.0031	
Emissions Factor: PM2.5		0.0057	
Emissions Factor: SO2		0.0030	
Annual Commuter Days	days per year	250	HDR assumption (5 days per week, 50 weeks per year)
Commuter Annual Factor	trips per day	2	HDR assumption
Annual Destination Travel Days	days per year	208	HDR assumption (4 days per week, 52 weeks per year)
Destination Travel Annual Factor	trips per day	2	HDR assumption
Average Trip Length – cycling	miles per trip	1.68	HDR assumption based on length of corridor
Automobile trips reduced per new cyclist		1/10	HDR Assumption

7.4.3 BENEFIT ESTIMATES

The project improvements are expected to decrease air contaminant emissions over the study period, as drivers divert to active transportation modes. This minor benefit is estimated to total approximately $556 over the benefits period when discounted by seven percent.

Table 12: Estimates of Environmental Sustainability Benefits, 2018 Dollars

	Over the Project Lifecycle		
	In Constant Dollars	Discounted at 7 Percent	Discounted at 3 Percent
Emissions Reduction	$1,853	$556	$1,077

7.5 Quality of Life

In terms of monetized quality of life benefits, the proposed project is expected to generate health and journey quality benefits for cyclists and pedestrians. Both of these benefits are monetized according to the methodology of the California Department of Transportation's Cal-B/C Active Transportation model (Cal-B/C AT), version 7.2. Health benefits are monetized as reduced mortality risk, per Cal-B/C AT methodology, and accrue to new cyclists and pedestrians that take up active transportation modes as a result of the project improvements. Monetized journey quality benefits accrue to existing cyclists and pedestrians in the BCA; additional consumer surplus journey quality benefits that accrue to new cyclists and pedestrians are conservatively omitted from benefit monetization in the BCA.

The following describes in more detail the methodology and assumptions utilized to estimate these benefits.

7.5.1 METHODOLOGY

Active Transportation Health Benefits – Reduced Mortality Risk

Increased physical activity—including increased cycling and walking activity—is generally considered to provide health benefits that accrue to individuals and to society. Societal benefits of increased physical activity come in many forms, including increased worker productivity, decreased absenteeism, and decreased health care costs. While various methodologies for monetizing these health benefits are published, this BCA adopts the methods of the Cal-B/C AT model, which monetizes increased active transportation activity (*i.e.*, walking and cycling) in the form of decreased mortality risk.

Per the Cal-B/C Active Transportation User Guide:

> *Cal-B/C AT adapts the method and data applied in the WHO HEAT model to estimate benefits of reduced mortality. The HEAT approach determines benefits as a reduction in the relative risk of death for bike facility users due to improved health conditions. The estimated reduction in risk for cycling and walking activity has been parameterized in a simplified form that is based on the distance traveled by mode. For cycling, there is a 4.5% reduction in risk for every 365 miles traveled per year (equal also to a 1 mile travel distance per day, every day). For walking, the annual risk reduction per 365 miles traveled is 9%. In addition, risk reduction is maximized at 30% for cycling and 45% for walking.*[4]

Consistent with the Cal-B/C AT methodology, this BCA references an individual annual mortality risk and decreases that risk proportionally as a result of increased cycling or walking activity. This decreased mortality risk applies to new cyclists and pedestrians who take up active transportation as a result of project improvements, according to the new cyclist and pedestrian count projections described in Section 6, and is scaled according to projected per-person annual cycling and walking mileage. Decreased mortality risk results in an expected reduction in annual fatalities,

[4] Cal-B/C Active Transportation Version 7.1, *User's Guide and Technical Documentation*; November 2019, p. 50.

and this is monetized according to the Economic Value of a Statistical Life per USDOT BCA Guidance.

The Cal-B/C AT model also includes methods to further monetize the health benefits of increased physical activity in the form of reduced absenteeism. This BCA does not quantitatively consider this additional form of health benefit, conservatively understating the total health benefits of project improvements.

Trip Quality Benefit

In addition to the health benefits that accrue from increased physical activity, this BCA leverages Cal-B/C AT methodology to quantitatively assess the value of improved journey quality for pedestrians and cyclists.

For pedestrians, journey quality benefits "are based on the results of stated preference surveys" and are monetized on a per-mile basis.[5] Cal-B/C AT parameters include per-mile pedestrian benefits for seven distinct types of pedestrian amenities: "Street Lighting," "Curb Level," "Crowding," "Pavement Evenness," "Information Panels," "Benches," and "Directional Signage." This BCA combines the per-mile benefits of Street Lighting, Curb Level, and Pavement Evenness—consistent with the pedestrian infrastructure improvements provided by this project—and aggregates total benefit as the product of per-mile benefits and expected pedestrian walking mileage over the period of analysis. This aggregation conservatively only considers the mileage walked by pre-existing pedestrians, excluding the additional consumer surplus gained by new pedestrians who begin walking as a result of project improvements.

Journey quality benefits for cyclists "are driven primarily by revealed preference research on cyclist route [choice]," leveraging "values [that] capture the preference for a designated bike route in comparison with a basic roadway."[6] Cal-BC A/T parameters include cycling "Facility Preference Factors as function of distance by facility class." For example, the Facility Preference Factor for Class I trails—consistent with the separated multi-use paths included in the project improvements—is 0.57, indicating that one mile travelled on a Class I trail is equivalent to 0.57 miles traveled on a standard roadway without bicycle facilities. Expressed another way, one mile of cyclist travel on a Class I trail is equivalent to a cyclist averting 0.43 miles of travel on a standard roadway. The mile-equivalent savings of improved cycling facilities is monetized according to average cyclist speed, per Cal-B/C AT parameters, and the per-hour valuation of cyclist time, per USDOT BCA Guidance. As is the case for pedestrian journey quality, cyclist journey quality in this BCA is only monetized for distance travelled by pre-existing cyclists, conservatively excluding additional consumer surplus gained by individuals that begin cycling as a result of project improvements.

7.5.2 ASSUMPTIONS

The assumptions and parameters used in the estimation of quality of life benefits are summarized in the table below.

[5] Cal-B/C Active Transportation Version 7.1, *User's Guide and Technical Documentation*; November 2019, p. 46.

[6] Cal-B/C Active Transportation Version 7.1, *User's Guide and Technical Documentation*; November 2019, p. 44.

Table 13: Assumptions Used in the Estimation of Quality of Life Benefits

Variable Name	Unit	Value	Source
Value of Averted Fatality	$ per event	$9,600,000	USDOT, *BCA Guidance for Discretionary Grant Programs*, January 2020.
Value of Time: Walking or Cycling	$ per hour	$30.40	
Mortality Rate - All Causes (Aged 20-64)	%	0.266%	CalTrans *Cal-B/C Active Transportation Model* Version 7.2; February 2020 Monetary values adjusted to dollars of 2018 per USDOT guidance.
Percentage Reduction in Mortality per 365 Annual Cycling Miles	%	4.5%	
Percentage Reduction in Mortality per 365 Annual Walking Miles	%	9.0%	
Average Cycling Speed	miles per hour	11.8	
Average Walking Speed	miles per hour	3.0	
Class I Bikeway Facility Preference Factor	marginal rate of substitution	0.57	
Pedestrian Value of Amenities: Total of Street Lighting, Curb Level, and Pavement Evenness	$ per mile	$0.223	
Annual Commuter Days	days per year	250	HDR assumption (5 days per week, 50 weeks per year)
Commuter Annual Factor	trips	2	HDR assumption
Annual Destination Travel Days	days per year	208	HDR assumption (4 days per week, 52 weeks per year)
Destination Travel Annual Factor	trips	2	HDR assumption
Average Trip Length – Walking	miles per trip	0.25	HDR Assumption
Average Trip Length – Cycling		1.68	

7.5.3 BENEFIT ESTIMATES

Total active transportation quality of life benefits amount to approximately $12.2 million over twenty years of project operations, when discounted at seven percent. New cyclist and pedestrian health benefits total $10.1 million, assuming a seven percent discount rate, while improved trip quality for existing cyclists and pedestrians provides and additional $2.0 million in monetized benefits.

Table 14: Estimates of Quality of Life Benefits, 2018 Dollars

	Over the Project Lifecycle		
	In Constant Dollars	Discounted at 7 Percent	Discounted at 3 Percent
Reduced Mortality Benefits: New Cyclists and Pedestrians	$34,683,221	$10,149,347	$19,960,189
Pedestrian and Cyclist Trip Quality	$5,763,742	$2,012,277	$3,573,231

8. Summary of Findings and BCA Outcomes

The tables below summarize the BCA findings. Annual costs and benefits are computed over the lifecycle of the project. As previously stated, construction is expected to be completed in 2024 and project benefits accrue during the full operation of the project from 2025 through 2044.

Table 15: Overall Results of the Benefit Cost Analysis, Millions of 2018 Dollars*

Project Evaluation Metric	7% Discount Rate	3% Discount Rate
Total Discounted Benefits	$89.6	$161.1
Total Discounted Costs	$28.2	$33.4
Net Present Value	$61.4	$127.6
Benefit-Cost Ratio	3.17	4.82
Internal Rate of Return (%)	22.4%	
Payback Period	8 Years	7 Years

** Unless Specified Otherwise*

Considering all monetized benefits and costs, the estimated internal rate of return of the project is 22.4 percent. With a 7 percent real discount rate, the investment would result in $61.4 million of total benefits in excess of costs, yielding a benefit-cost ratio of approximately 3.17.

With a 3 percent real discount rate, the Net Present Value of the project would increase to $127.6 million, for a benefit-cost ratio of 4.82.

Table 16: Benefit Estimates by Selection Criteria, 2018 Dollars

BUILD Merit Criteria	Benefit Categories	7% Discount Rate	3% Discount Rate
Safety	Accident Reduction Benefit - Vehicles	$47,491,042	$84,298,256
	Accident Reduction Benefit - Bike/Ped		
Economic Competitiveness	Vehicle Operating Cost Savings	$29,634,713	$52,610,468
Environmental Sustainability	Emissions Reduction - Vehicle	$345,373	$609,675
	Emissions Reduction - Bicycles		
State of Good Repair	Pavement Maintenance Savings	$556	$1,077
Quality of Life	Pedestrian and Cyclist Reduced Mortality	$12,161,623	$23,533,420
	Pedestrian and Cyclist Trip Quality		
Total Benefit Estimates		**$89,633,306**	**$161,052,897**

9. BCA Sensitivity Analysis

The BCA outcomes presented in the previous sections rely on a large number of assumptions and long-term projections, both of which are subject to considerable uncertainty.

The primary purpose of the sensitivity analysis is to help identify the variables and model parameters whose variations have the greatest impact on the BCA outcomes: the “critical variables.”

The sensitivity analysis can also be used to:

- Evaluate the impact of changes in individual critical variables – how much the final results would vary with reasonable departures from the “preferred” or most likely value for a variable; and
- Assess the robustness of the BCA and evaluate, in particular, whether the conclusions reached under the “preferred” set of input values are significantly altered by reasonable departures from those values.

The outcomes of the quantitative analysis for the Jefferson Avenue and 20th Street Revitalization Corridors project, using a 7 percent discount rate, are summarized in the table below. The table provides the percentage changes in project NPV associated with variations in variables, parameters, or calculations (listed in row), as indicated in the column headers.

The BCA model that is provided as part of this application and technical appendix also allows additional sensitivity analyses.

Table 17: Quantitative Assessment of Sensitivity, Summary

Parameters	Change in Parameter Value	New NPV	% Change in NPV	New B/C Ratio
Discount Rate	Discount Rate of 3%	$127.6 MM	107.9%	4.82
Benefits Period	Benefits Period of 15 Years	$47.1 MM	-23.3%	2.67
	Benefits Period of 25 Years	$71.7 MM	16.9%	3.54
Crash Reduction Safety Benefits	Reduce Crash Safety Benefits by 50 Percent	$37.7 MM	-38.7%	2.33
Active Transportation Benefits	Exclude Cal-B/C Active Transportation Benefits	$49.2 MM	-19.8%	2.74
New Cyclist Diversion from Automobiles	Assume 5 Percent of New Cyclists Divert from Automobiles	$61.4 MM	0.0%	3.17
	Assume 75 Percent of New Cyclists Divert from Automobiles	$61.4 MM	0.0%	3.17
Pedestrian Journey Quality	Reduce per Mile Walking Journey Quality Benefits by 50 Percent	$61.3 MM	-0.2%	3.17
Cycling Journey Quality	Assume Cycling "Facility Preference Factor" to be Zero	$63.8 MM	3.9%	3.26
	Assume Cycling "Facility Preference Factor" to be One	$59.6 MM	-2.9%	3.11
Mortality Reduction: Pedestrians and Cyclists	Reduce Mortality Rate by 50 Percent	$56.3 MM	-8.3%	2.99
Annual O&M Savings	50% Reduction in Annual O&M Savings	$61.2 MM	-0.3%	3.17
	50% Increase in Annual O&M Savings	$61.6 MM	0.3%	3.18
Total Project Cost	20% Reduction in Project Costs	$67 MM	9.2%	3.97
	20% Increase in Project Costs	$55.8 MM	-9.2%	2.65